(12) UK Patent Application (19) GB (11) 2 049 102 A

(21) Application No 8014336
(22) Date of filing 30 Apr 1980
(30) Priority data
(31) 35514
(32) 3 May 1979
(33) United States of America (US)
(43) Application published 17 Dec 1980
(51) INT CL³ F16C 13/00 B05C 1/08 B41F 31/26
(52) Domestic classification F2U 208 1 21X 228 22X
(56) Documents cited
GB 1463284
GB 1348242
GB 644789
(58) Field of search
F2U
(71) Applicant
C.S.I. Corp., 12900 West Solver Spring Drive, Butler, Wisconsin, U.S.A.
(72) Inventors
Jerome D. Jenkins,
Neal G. Schultz
(74) Agent
Marks & Clerk

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

(54) Transfer Roll

(57) A transfer roll 1 for use in transferring ink or other medium to a print roll, or directly to material that is being printed, has a layer 4 of corrosion resistant metal and an outer ceramic coating 5 which may be ground to provide a relatively smooth surface. A multiplicity of holes or depressions 6 are formed in the ceramic coating 5, and a pulsed laser beam may be used for this process. The depression distribution and volume determines the delivering capacity of the roll 1. Prior to forming the depressions, the porous ceramic layer 5 may be impregnated with a sealing material to provide an impervious surface. The transfer roll has an extremely hard, durable, abrasion resistant surface and provides a uniform distribution of ink or other medium on the material being printed.

FIG. 1

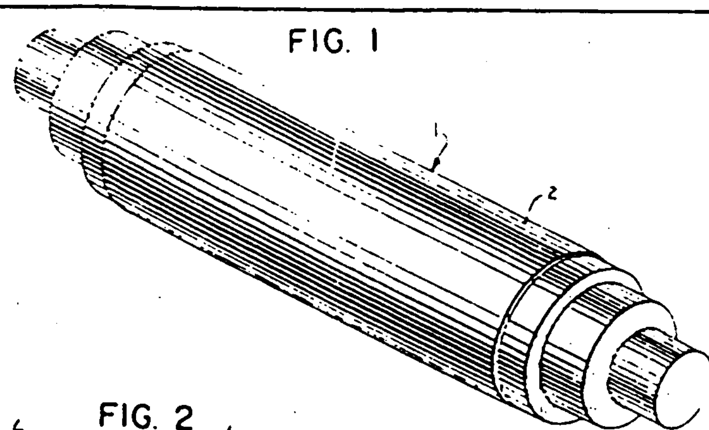
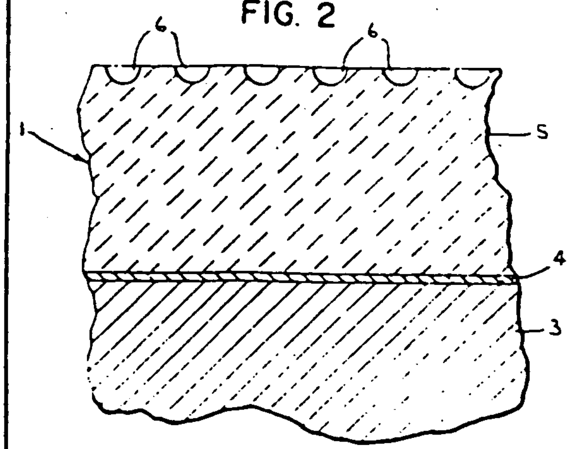


FIG. 2



GB 2 049 102 A

2049102

FIG. 1

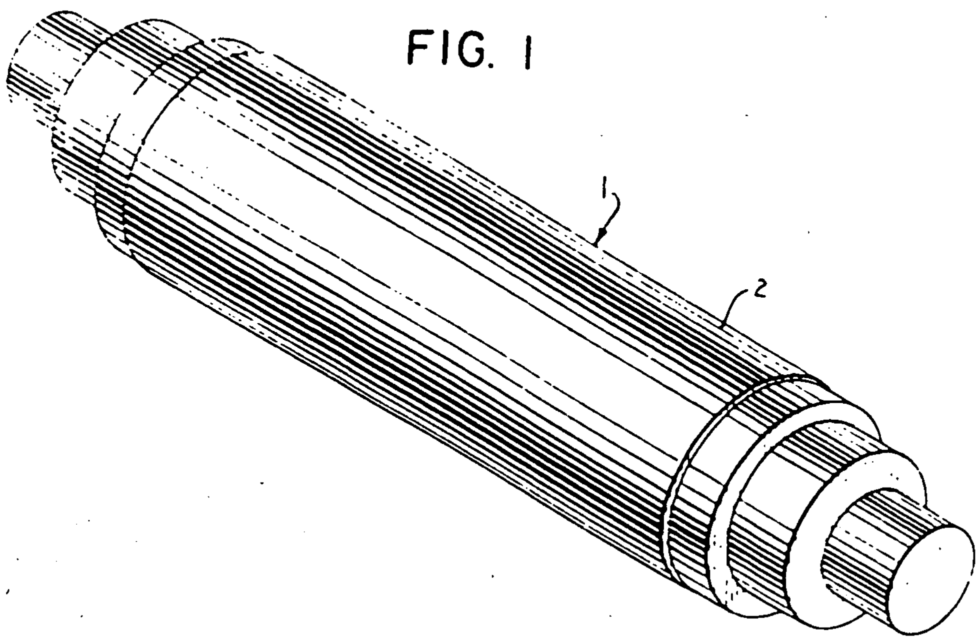
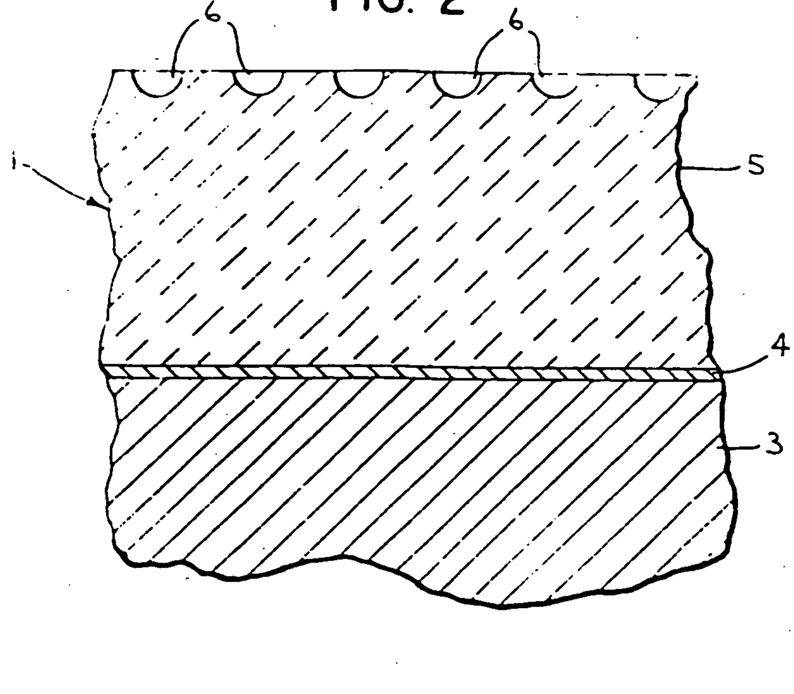


FIG. 2



SPECIFICATION
Transfer Roll

Background of the Inv nti n

A transfer roll is used in the printing industry to transfer a specified amount of ink or oth r medium from the fountain roll or directly from the fountain to the print roll or material being printed. If the surface of the roll is too coarse, excessive ink or other medium will be transferred to the print roll or material, and hence a blotchy, smeared print will result. On the other hand, if the finish of the roll is too smooth, a light or skip pattern may appear in the printed work. Obviously, scrapes, gouges and scratches in the surface of the roll can cause blobs of ink to transfer to the printing.

In commercial practice, the roll runs against a doctor blade (in either the reverse or forward position) or a wiper roll. The amount of medium transferred to the print roll or material is the combination of the medium film remaining between the doctor blade or wiper roll and the top surface of the transfer roll, along with the medium contained within the pores or irregularities in the roll surface. As the doctor blade is normally made of hard, wear resistance metal, it is a prime requirement for the outer surface on the transfer roll to be resistant to the abrasion caused by the doctor blade.

It is also a requirement that the roll be resistant to corrosion, since many customers use water base materials and the water can work through the roll coating and corrode the underlying substrate. Extensive corrosion can lift the coating from the roll and destroy the roll finish.

In the past, in order to achieve the desired delivering capacity, the outer surface of steel rolls has been roughened, as by grit blasting, in order to provide a degree of irregularity to develop the desired distribution of medium. Roughened rolls of this type have generally been plated with a metal, such as chromium. However, the chromium coating does not in itself provide adequate corrosion resistance for the steel substrate. The randomly roughened surface also does not provide a precise and controlled distribution of medium to the print roll.

To obtain more uniform distribution, rolls have been precisely engraved by forming pyramid-shaped, truncated pyramid-shaped or helical-groove recesses in the roll surface. The outer surface has then been plated with chromium. While rolls of this type have provided better control and distribution of ink than the earlier grit blasted rolls, the chromium during plating tends to build up on the edges bordering the recesses so that a non-uniform surface results. Furthermore, the chromium does not provide adequate protection against corr si n. Th base metal of the roll is necessarily soft in ord r to form th engraved p ckets and thus is susc ptible to extensive w ar.

Ceramic coat d rolls hav also been used t which a coating f ceramic material in th rang of 0.001 to 0.060 inch is applied by a plasma arc process to the outer surface of th st el roll. The resulting ceramic coating has a naturally roughened, porous surfac , similar to that obtained by grit blasting. While th ceramic coating is extremely durable and corr sion resistant, the ceramic coated rolls, as used in th past, do not provide precise and uniform ink distribution because of the random surface roughness inherent with the plasma arc process.

Metal engraved rolls also have been coated with a thin layer of ceramic, generally 0.0005 to 0.0020 inch thick, to enhance their wearability. The amount of ceramic added does improve wearability. However, the thin layer of ceramic does wear through exposing metal-ceramic interfaces to the corrosion action of inks with resulting spalling of the ceramic.

Summary of the Invention

The invention is directed to a material transfer roll which provides a precise distribution of ink or other materials to the print roll or material being printed or coated. In accordance with the invention, the roll is coated with a relatively thick layer of a ceramic material. The ceramic layer is ground to provide a relatively smooth outer surface, and a multiplicity of holes or depressions are then formed in the ceramic layer by a pulsed laser beam. The hole distributions can be in the range of 25×25 to 600×600 per square inch, and the hole distribution, as well as the depth or volume of the depressions, determines the delivery capacity of the roll.

The roll produced in accordance with the invention has an extremely hard, abrasion resistant and corrosion resistant surface, thereby making the roll resistant to abrasion and mechanical damage. Due to the precise distribution and depth of the holes or depressions, a uniform and controlled distribution of material can be obtained.

As a feature of the invention, prior to forming the holes or depressions, the porous ceramic layer can be impregnated with a sealing material, such as polytetrafluoroethylene, to provide an impervious outer layer. The sealant not only fills the voids of the ceramic layer to provide increased corrosion protection for the base metal of the roll, but can also serve as a lubricant to reduce doctor blade or wiper roll wear, as well as contributing anti-wetting properties which aid in cleaning the roll.

Other objects and advantages will appear in the course of the following description.

Description of the Drawings

The drawings illustrate the best mode presently contemplated of carrying out the inventi n.

In the drawings:

Fig. 1 is a p rspective view of a transf r roll; and

Fig. 2 is an enlarged fragm ntary sectional view showing th construction of th roll.

Description of th !llustrat d Embodim nt

Fig. 1 shows a transfer roll 1 which is gen rally used in the printing industry to transfer a s t amount of ink or other medium fr m the fountain roll to the print roll, although it can b used without either roll as well. As shown in Fig. 2, th roll 1 has a cylindrical surface 2 which is composed of a base or substrate 3, generally formed of carbon steel and a layer of corrosion resistant metal 4 is applied over the base 3. Covering the corrosion resistant layer 4 is a layer of ceramic material 5.

The corrosion resistant layer 4 can be any corrosion resistant metal, such as stainless steel, nickel, titanium, aluminum-titanium and the like. Generally, the corrosion resistant layer will have a thickness in the range of 0.001 to 0.004 inch. As the ceramic layer 5 is porous, the corrosion resistant layer acts to prevent contact of water or other corrosive media with the base metal 3.

The ceramic layer 5 has a thickness in the range of 0.003 to 0.080 inch, and preferably about 0.040 inch and can be applied to the outer surface of the roll by a conventional plasma arc process in which a torch produces and controls a high velocity inert plasma gas stream that can attain temperatures over 30,000°F. The hot gas stream melts and accelerates to high velocity, particles of the ceramic material. When the molten particles strike the substrate, the impact forms a dense, hard ceramic coating.

Although the plasma arc process is the preferred method of applying a ceramic layer to a roll, other methods such as oxyacetylene flame spraying, chemical vapor deposition, or glass frit fusing processes can also be used.

The composition of the ceramic coating itself is conventional and can be formed of oxides such as aluminum oxide, titanium oxide, chromium oxide, nickel oxide, manganese oxide, or the like, or mixtures of the oxides; carbides such as tungsten carbide, chromium carbide, boron carbide, or the like, or mixtures of carbides, used in a matrix of suitable corrosion resistant metals such as nickel, chromium, cobalt, or the like, or alloys containing these metals; nitrides such as titanium nitride, hafnium nitride, vanadium nitride, zirconium nitride, or the like, or mixtures of nitrides; silicides such as zirconium silicide, tantalum silicide, or boron silicide, or the like, or mixtures of silicides with silicon dioxide; or mixtures of oxides, carbides, nitrides, silicides and metals and alloys.

A typical formulation of the ceramic material is as follows in weight percent:

Aluminum oxide	48.42%
Titanium dioxide	51.58%

Formulations of from 1.00 weight percent titanium dioxide, balance aluminum oxide to 80 percent titanium di xid , 20 weight p rcent alumina can also be used.

For best results, the mixture of th ceramic components should be presinter d and ground. Th ground mixture is then applied t th surface of the roll through the plasma arc process to provide a homogeneous ceramic coating. Well mixed unsintered formulations can be used as well but they suffer from a lack of complete homogeneity.

To improve the bond between the ceramic coating and the metal substrate, the corrosion resistant metal, instead of being applied to the base metal as a separate layer, can be applied with a ceramic material during the plasma arc process. In this manner a graduated content of the corrosion resistant metal can be obtained throughout at least a portion of the relatively thic ceramic layer, with the inner portion of the ceramic layer having a relatively high corrosion resistant metal content and the outer portion of the ceramic layer having a relatively low content of the corrosion resistant metal. The graduated corrosion resistant metal content throughout the thickness of the ceramic layer is possible due to the relative thick ceramic layer. This technique is not feasible when using a thin ceramic coating a used in the past.

After the ceramic layer is applied to the roll, th outer surface of the ceramic layer is ground to a relatively smooth surface, generally less than 16 RMS surface roughness.

In accordance with the invention, a multiplicit of holes or depressions 6 are drilled into the ceramic layer by a pulsed laser beam. The pulsec laser beam of appropriate focal diameter is focused on the surface of the roll and as the roll rotates and traverses under the laser focal point, holes or depressions are machined in the cerami layer by the pulsed beam. Adjustment of the foca diameter and the power of the laser permits machining of holes of various diameters and depths, while regulating the pulsed rate, the speed of rotation and traverse, permits machinin of a varying number of holes per square inch of roll surface. The volume of the holes, in conjunction with the distribution or pattern of the holes, determines the ink or medium delivering capacity of the surface.

The holes, as best shown in Fig. 2, have a generally hemispherical configuration. If greater depth is desired, the holes can be generally cylindrical with a rounded bottom. At increasing depth, the holes will tend to be cone shaped. Due to the action of the laser beam, the portion of the ceramic material bordering the holes will be glazed providing a completely impervious surface which thereby aids in the delivery of the ink r medium and cleaning of the roll.

The holes are applied in a pattern, generally ranging from 25×25 per square inch to 600×600 per square inch, with the hole diameters being in the range of 0.005 to 0.035 inch. Holes of this size are not generally visible to the naked eye. Th depth of the holes can vary from 0.0005 to 0.0070 inch, with the sp cific d pth depending on the d livery characteristics that are required. Th ceramic c ating has a substantially greater thickness than the depth of the holes, s that the holes nly penetrat the uter portion of the

ceramic layer. By removing a layer up to 0.0080 inch from the ceramic surface by grinding, th holes will b removed and the ceramic layer can then be re-engraved with a new or diff rent hol distribution.

As a feature of the invention, prior to drilling the holes in the ceramic layer, the porous ceramic layer 4 can be impregnated with a sealing material such as a fluorocarbon, and in particular polytetrafluoroethylene (Teflon-DuPont trademark), phenolic resins, silicones, nylon, sodium silicate, and the like. The sealing material should be non-metallic and should be compatible with the solvent or water base materials to be printed. It has been found that polytetrafluoroethylene is particularly satisfactory as the sealant because it not only seals the voids or pores in the ceramic layer, thereby aiding in protecting the base 1 against corrosion, but due to its low coefficient of friction, it acts as a lubricant to prevent wear of the roll by action of the doctor blade or wiper roll. In addition, the polytetrafluoroethylene coating has anti-wetting properties which facilitate cleaning of the roll after use.

The sealant can be impregnated into the ceramic material either by incorporating the sealant with the ceramic material in the plasma arc process, or preferably by vacuum impregnation of the ceramic layer after the ceramic layer is applied to the roll. In this conventional manner of impregnation, a vacuum is applied to the roll to remove air and other gases from the voids or interstices of the ceramic coating. While maintaining the vacuum, the roll is exposed to a solvent solution or dispersion of the sealant, causing the sealant to impregnate the voids. After impregnation, the roll is dried, preferably by heating, to evaporate the residual solvent.

The following examples illustrate the manner of producing the transfer roll of the invention.

Example I

A cylindrical steel roll having a diameter of 4.085 inches was coated with a corrosion resistant coating of nickel titanium having a thickness of 0.004 inch.

A ceramic presintered and reground composition having the following formulation in weight percent was applied over the corrosion resistant coating by a plasma arc process:

Aluminum oxide	48.42%
Titanium dioxide	51.58%

The ceramic coating has a thickness of 0.060 inch.

The outer surface of the ceramic coated roll was ground to provide a surface finish of 8 RMS, and the roll was then mounted in a fixture and rotated and traversed axially with relation to a pulsed laser beam having a focal diam t r of 0.002 and an averag power of 10 watts to machine a multiplicity f holes in th ceramic c ating. The holes had a diameter of 0.0025 inch, a depth of 0.0020 inch and were distributed in a pattern of 200×230 per square inch of roll surfac .

The resulting roll pr vided precise and uniform distribution of medium to the print r ll when used in a flexographic printing process.

Example II

A cylindrical steel roll having a diameter of 12.063 inches was coated with a ceramic composition having the following formulation in weight percent through use of a plasma arc process:

Aluminum oxide	90.00%
Titanium dioxide	2.50
Zirconium silicate	7.50

The ceramic coating has a thickness of 0.030 inch.

The ceramic coating was impregnated with polytetrafluoroethylene by a vacuum impregnation process.

The outer surface of the ceramic coated roll was ground to provide a surface finish of 12 RMS, and the roll was then mounted in a fixture and rotated and traversed axially with relation to a pulsed laser beam having a focal diameter of 0.0100 and a power of 72 watts to machine a multiplicity of holes in the ceramic coating. The holes has a diameter of 0.0250 inch and a depth of 0.0030 inch and were distributed in a pattern of 60×50 per square inch of roll surface.

The resulting roll provided precise and uniform distribution to the print roll used in a paint coating process.

While the above description has shown the invention as being used as an ink and paint transfer roll, it is contemplated that the roll can be used for the transfer of other types of materials, such as glue, toners, and the like.

Moreover, the holes drilled by the pulsed laser beam need not extend over the entire periphery of the roll, but can be applied in any desired pattern, and the depth or volume of the holes can be varied throughout the periphery of the roll to provide varying delivering capacities for different portions of the roll surface.

Claims

1. A liquid transfer roll assembly, comprising a generally cylindrical roll, and a ceramic coating disposed on the outer surface of the roll, said coating having a multiplicity of holes extending only partially through said ceramic coating, said holes having a pattern and depth to provide a transfer of liquid from said roll to a cooperating element.

2. The r ll of claim 1, wher in said holes having a distribution in the rang of 25×25 to 600×600 p r square inch of roll surfac .

3. Th r ll of claim 1, wh rein the holes have a diameter in the range of 0.0005 inch t 0.035 inch

and have a depth in the range of 0.0005 to 0.0070 inch.

4. The roll of claim 1, wherein each of said holes has a generally rounded glazed bottom.

5. The roll of claim 1, wherein said holes are produced by a pulsed laser beam.

6. The roll of claim 1, and including a sealing material impregnated within the voids in said ceramic coating.

7. The roll of claim 6, wherein said sealing material comprises polytetrafluoroethylene.

8. A liquid transfer roll assembly, comprising a generally cylindrical roll, a porous ceramic coating disposed on the outer surface of the roll and having a thickness in the range of 0.003 to 0.080 inch, and a sealing material impregnated within the interstices of said ceramic coating, said ceramic coating having a multiplicity of holes extending only partially through said coating, said holes having a pattern and depth to provide a transfer of liquid to a cooperating element, said holes being produced by a pulsed laser beam.

9. The roll of claim 8, wherein said cylindrical roll includes a ferrous substrate and said roll assembly includes a layer of corrosion resistant metal applied to said ferrous substrate beneath said ceramic coating.

10. The roll assembly of claim 1, wherein said ceramic coating contains a corrosion resistant metal, the content of the corrosion resistant metal being progressively decreased in an outward direction through the ceramic coating.

11. A method of forming a liquid transfer roll assembly, comprising the steps of coating the outer surface of a generally cylindrical roll with a layer of ceramic material, and drilling a multiplicity of holes partially through the ceramic coating by use of a pulsed laser beam, said holes being formed with a distribution and depth to provide transfer of liquid from said roll to a cooperating element.

12. The method of claim 11, and including the step of grinding the outer surface of the ceramic material prior to drilling the holes to provide a relatively smooth outer surface.

13. The method of claim 11, wherein said ceramic coating is porous and the method includes the step of impregnating the layer of ceramic material with a sealing material prior to drilling the holes.

14. The method of claim 13, wherein the sealing material is polytetrafluoroethylene.

15. A method of forming a liquid transfer roll assembly, comprising the steps of coating the outer surface of a generally cylindrical metal roll with a layer of ceramic material, grinding the outer surface of the layer of ceramic material to provide a relatively smooth outer surface, contacting the outer surface of said roll with a pulsed laser beam to drill holes partially through said layer of ceramic material in a pattern ranging from 25 × 25 to 600 × 600 holes per square inch of roll surface.

16. The method of claim 15, and including the step of impregnating the layer of ceramic material with a sealing material prior to contacting the ceramic layer with said laser beam.

17. The method of claim 15, and including the step of impregnating the layer of ceramic material with a sealing material, and thereafter contacting the ceramic layer with said laser beam.

18. A liquid transfer roll assembly substantially as hereinbefore described with reference to the accompanying drawings.

19. A method as claimed in claim 11 or 15, substantially as hereinbefore described with reference to the accompanying drawings.

20. A liquid transfer roll assembly when produced by the method as claimed in any one of claims 11 to 17 and 19.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1980. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.